

This material is based on slides provided with the book 'Stochastic Local Search: Foundations and Applications' by Holger H. Hoos and Thomas Stützle (Morgan Kaufmann, 2004) - see www.sls-book.net for further information.

Iterated Local Search — Framework

Given

- some local search algorithm: LocalSearch
- more general: any problem specific optimization algorithm

Question

- can such an algorithm be improved by iteration?

YES

ILS — Notation

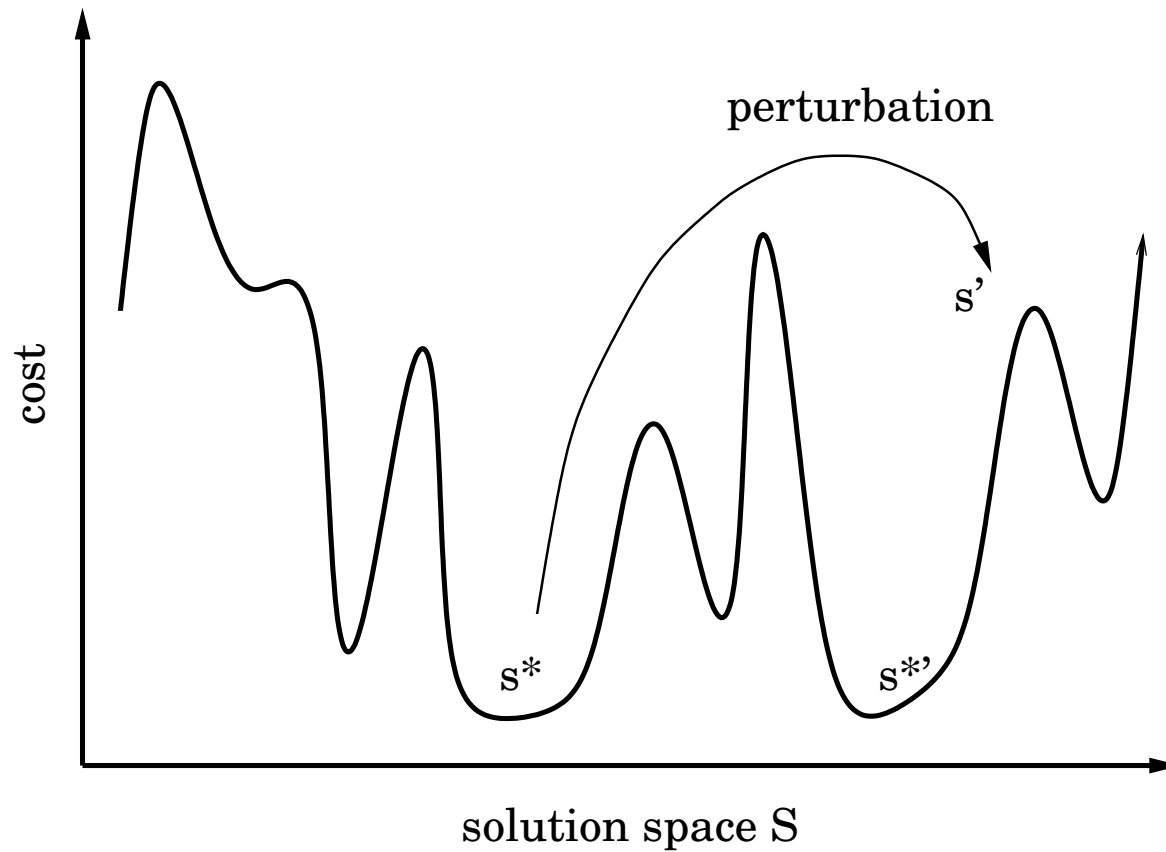
- \mathcal{S} : set of (candidate) solutions
- s : solution in \mathcal{S}
- f : cost function
- $f(s)$: cost function value of solution s
- s^* : locally optimal solution
- \mathcal{S}^* : set of locally optimal solutions
- LocalSearch defines mapping from $\mathcal{S} \mapsto \mathcal{S}^*$

ILS – Principle

Searching in \mathcal{S}^*

- LocalSearch leads from a large space \mathcal{S} to a smaller space \mathcal{S}^*
- define a biased walk in \mathcal{S}^*
 - given a s^* , perturb it: $s^* \rightsquigarrow s'$
 - apply LocalSearch: $s' \rightsquigarrow s^{*'}$
 - apply acceptance test: $s^*, s^{*'} \rightsquigarrow s_{new}^*$

ILS – Pictorial view



ILS – Procedural view

procedure *Iterated Local Search*

$s_0 \leftarrow \text{GenerateInitialSolution}$

$s^* \leftarrow \text{LocalSearch}(s_0)$

repeat

$s' \leftarrow \text{Perturbation}(s^*, \text{history})$

$s^{*'} \leftarrow \text{LocalSearch}(s')$

$s^* \leftarrow \text{AcceptanceCriterion}(s^*, s^{*'}, \text{history})$

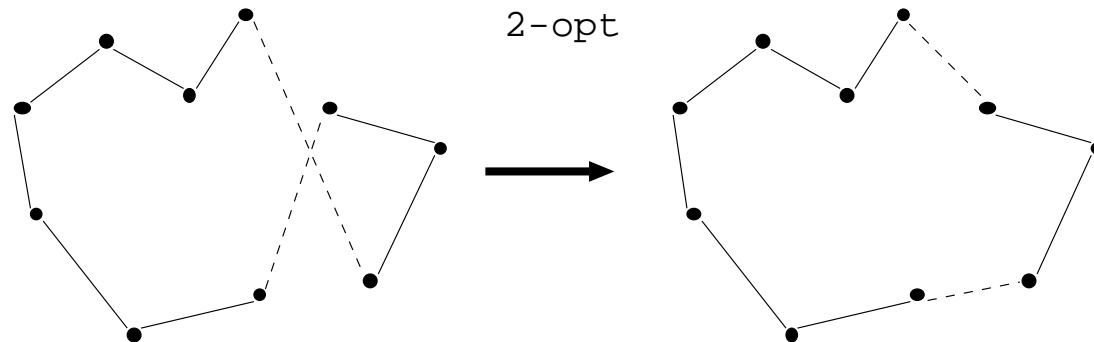
until termination condition met

end

ILS Examples — TSP

basic ILS algorithm for TSP

- GenerateInitialSolution: greedy heuristic
- LocalSearch: 2-opt, 3-opt, LK, (whatever available)



- Perturbation: double-bridge move (a 4-opt move)
- AcceptanceCriterion: accept $s^{*'}$ only if $f(s^{*'}) \leq f(s^*)$

ILS — Perturbation

- important: **strength** of perturbation
 - **too strong**: close to random restart
 - **too weak**: LocalSearch may undo perturbation
- strength of perturbation may vary at run-time
- perturbation should be complementary to LocalSearch

ILS — Acceptance Criterion

- AcceptanceCriterion has strong influence on nature and effectiveness of walk in \mathcal{S}^*
- controls balance between intensification and diversification
- simplest case: Markovian acceptance criteria
- extreme intensification:
 $\text{Better}(s^*, s^{*'}, history)$: accept $s^{*'}$ only if $f(s^{*'}) < f(s^*)$
- extreme diversification:
 $\text{RW}(s^*, s^{*'}, history)$: accept $s^{*'}$ always
- many intermediate choices possible